



**US Army Corps
of Engineers**
Waterways Experiment
Station

Preliminary Data Summary for September 1995 CERC Field Research Facility

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Coastal Engineering Research Center

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September 1995 Preliminary Data Summary

by Field Research Facility

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Contents

Preface	iv
1— Introduction	1
2— Meteorological Data	7
3— Wave Data	12
4— Current Data	17
5— Visual Observations	20
6— Water Levels	22
7— Bathymetry	24
8— Special Events	27

List of Figures

<u>No.</u>		
1	FRF Location Map	2
2	Month at a Glance	3
3	Instrument Locations at FRF	6
4	Meteorological Monthly Summary	8
5	Wave Heights and Periods	16
6	Water Levels	22
7	CRAB Profiles	24
8	CRAB Profile Envelope	25
9	FRF Bathymetry (22 August 95)	26

List of Tables

<u>No.</u>		
1	Instrument Status/Data Availability	4
2	Gauge Locations	5
3	Meteorological Data	9
4	Wave Data	13
5	Current Meter Data	18
6	Visually Observed Current Data	19
7	Visual Observations	21
8	Water Levels	23

Preface

Contents

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

These reports are now available via the World Wide Web at <http://frf.wes.army.mil/frf.html>

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and criticisms are welcome.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511 (*baron@duck.wes.army.mil*).

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

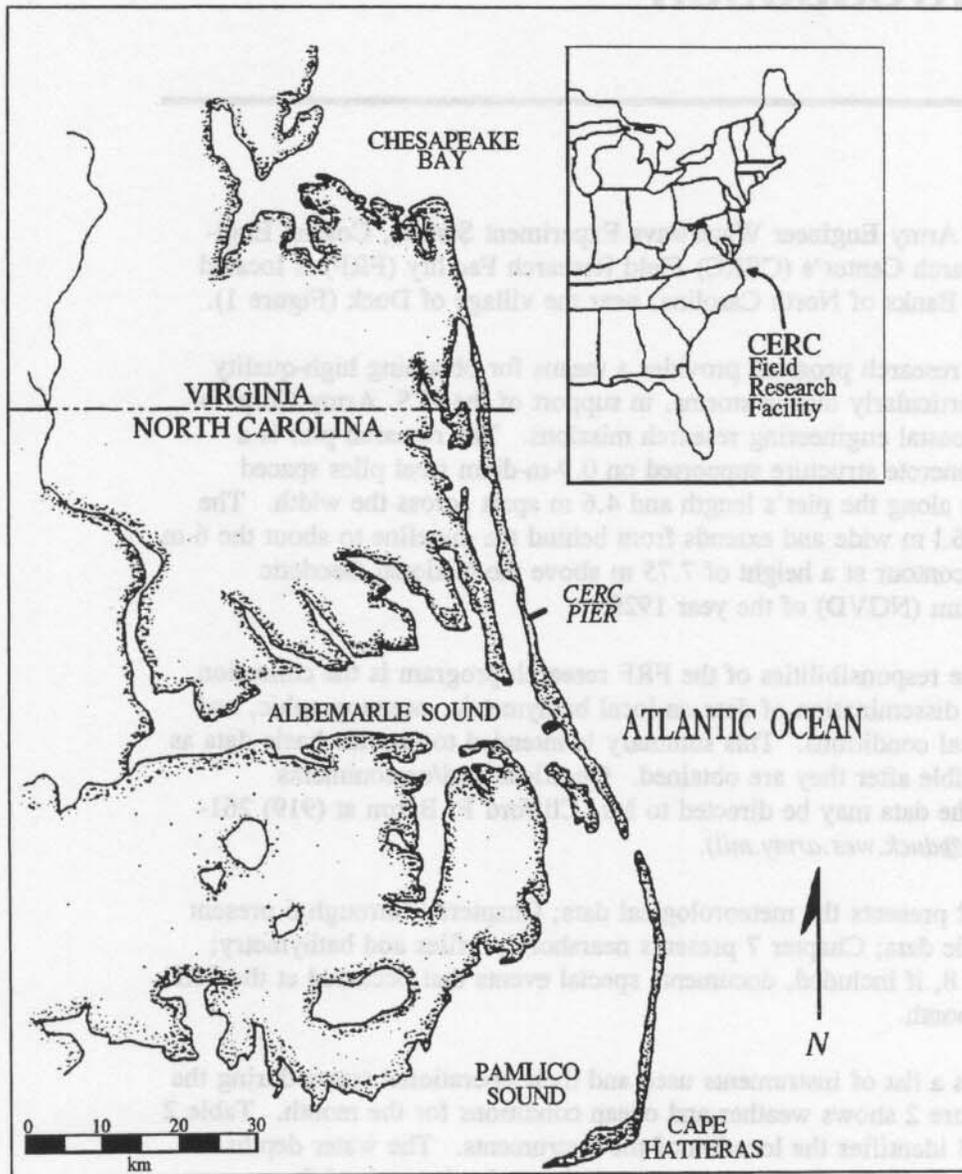


Figure 1. FRF Location Map

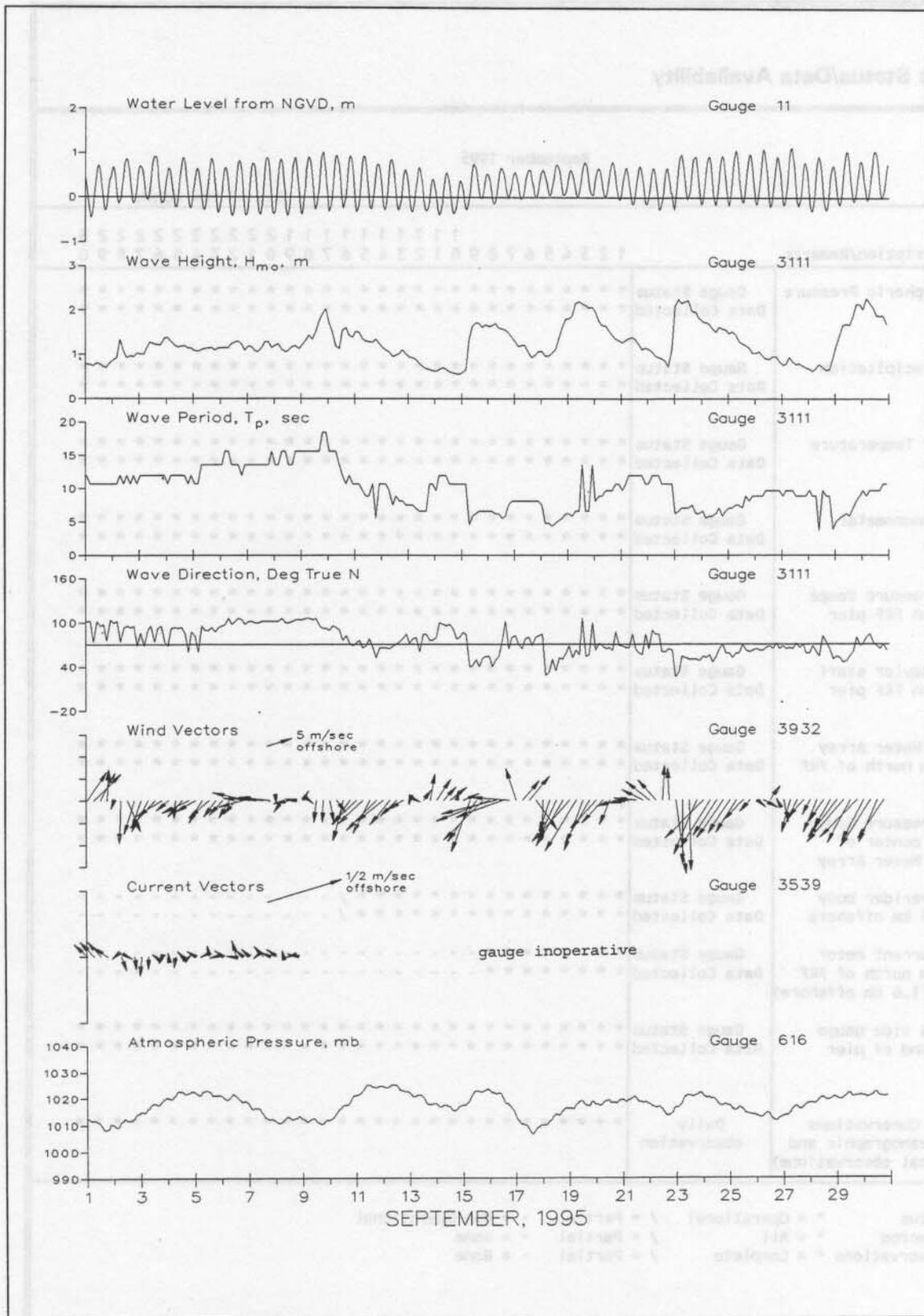


Figure 2. Month at a Glance

**Table 1
Instrument Status/Data Availability**

			September 1995																																
			Day of the month																																
Gauge ID	Description/Remarks		1	2	3	4	5	6	7	8	9	0	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3		
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	-	-	-	-	-	-	-	-	-	-	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	-	-	-	-	-	-	-	-	-	-	
3539	Current meter 343 m north of FRF pier (1.6 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	

Gauge Status * = Operational / = Partial - = Non-Operational
 Data Collected * = All / = Partial - = None
 Visual Observations * = Complete / = Partial - = None

**Table 2
Gauge Locations**

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates		Gauge Depth NGVD, m	Water Depth NGVD, m
				Crossshore m	Longshore m		
616	Atmospheric Pressure	36 10' 57.03"	75 45' 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11' 1.23"	75 44' 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10' 57.71"	75 44' 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11' 1.04"	75 44' 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11' 19.14"	75 44' 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11' 11.28"	75 44' 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11' 13.70"	75 44' 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11' 12.48"	75 44' 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11' 14.06"	75 44' 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10' 5.10"	75 41' 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11' 23.57"	75 44' 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11' 1.25"	75 44' 42.60"	596.49	514.20	Surface	-7.62

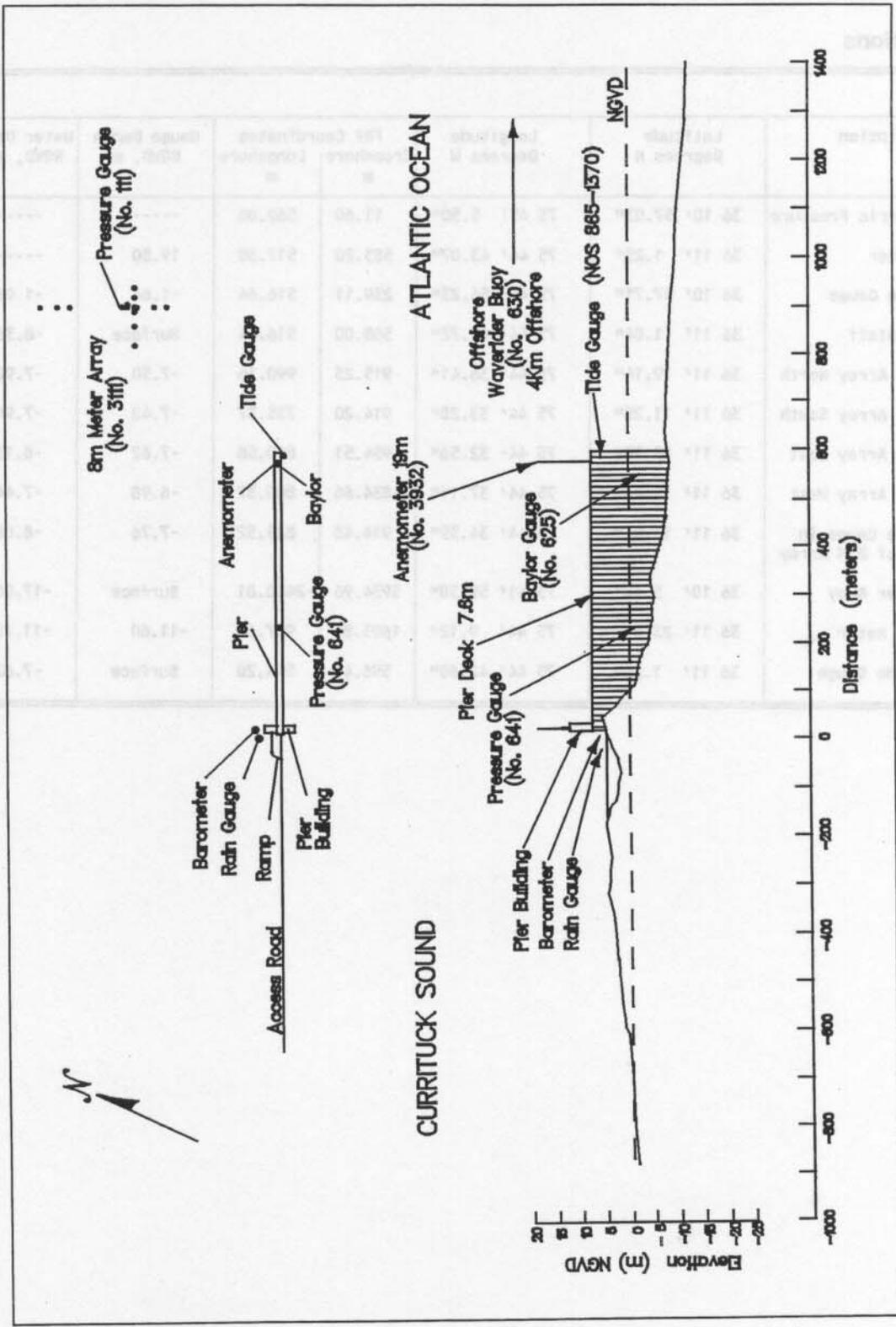


Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAXstation 4000. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(\text{C} \times 9/5) + 32 = \text{F}$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

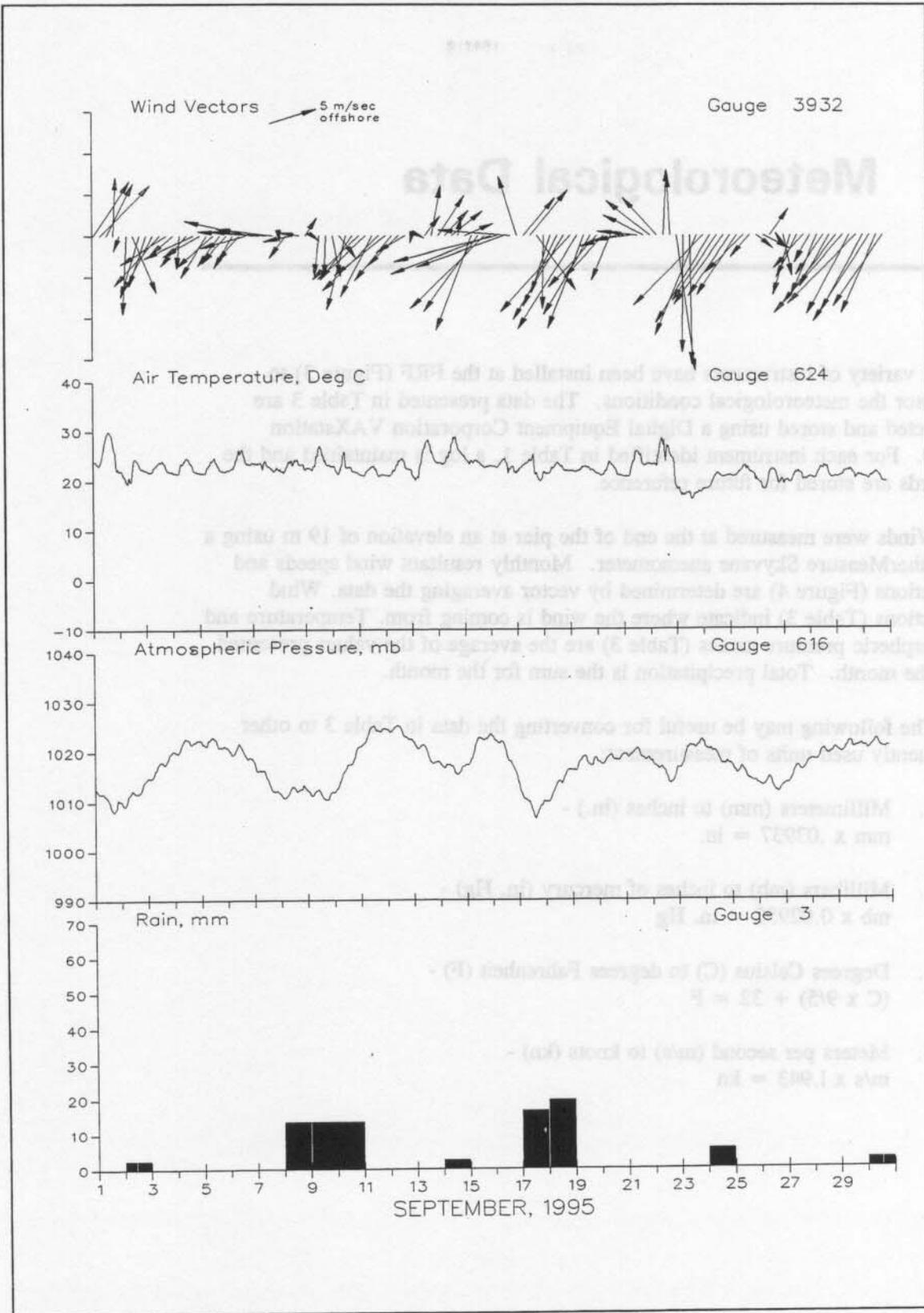


Figure 4. Meteorological Monthly Summary

**Table 3
Meteorological Data**

Sep 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	8	209	24.0	1012.6	0
	700	8	220	24.1	1011.8	0
	1300	7	203	29.8	1010.1	0
	1900	7	182	26.2	1008.7	0
2	100	2	17	22.1	1009.8	0
	700	10	1	19.6	1011.5	3
	1300	7	340	24.4	1011.8	0
	1900	8	14	22.7	1013.0	0
3	100	6	16	22.1	1014.9	0
	700	8	24	22.8	1016.4	0
	1300	8	37	23.9	1018.0	0
	1900	6	53	22.2	1019.2	0
4	100	3	45	21.7	1020.0	0
	700	4	3	23.4	1021.7	0
	1300	4	35	24.6	1022.5	0
	1900	6	61	22.1	1022.1	0
5	100	4	56	21.7	1021.8	0
	700	6	27	22.9	1022.5	0
	1300	5	44	24.7	1022.5	0
	1900	4	31	22.2	1021.0	0
6	100	4	36	22.2	1020.5	0
	700	4	26	23.0	1020.3	0
	1300	4	37	25.8	1020.7	0
	1900	5	72	23.4	1018.8	0
7	100	7	104	23.6	1017.1	0
	700	6	94	23.7	1016.3	0
	1300	6	1	23.1	1014.1	0
	1900	6	1	21.9	1012.2	0
8	100	1	353	22.5	1011.2	0
	700	3	32	22.9	1011.7	14
	1300	3	75	23.7	1012.7	0
	1900	2	1	23.3	1012.5	0
9	100	2	207	22.7	1012.3	0
	700	1	313	23.0	1012.1	14
	1300	5	5	26.9	1011.2	0
	1900	5	1	23.3	1010.8	0
10	100	5	350	23.0	1012.2	0
	700	3	326	22.4	1015.1	14
	1300	9	12	22.7	1017.4	0
	1900	6	31	22.0	1019.0	0

Table 3
Meteorological Data (continued)

Sep 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	7	41	21.2	1021.3	0
	700	7	42	22.0	1023.6	0
	1300	8	23	23.0	1024.9	0
	1900	9	40	21.1	1024.3	0
12	100	7	47	21.1	1024.4	0
	700	7	35	22.2	1025.0	0
	1300	5	41	24.1	1024.5	0
	1900	4	54	22.4	1022.6	0
13	100	1	11	21.0	1021.5	0
	700	1	299	22.6	1021.3	0
	1300	3	213	27.9	1019.7	0
	1900	6	188	25.5	1017.8	0
14	100	6	209	23.6	1017.5	0
	700	4	218	24.1	1017.4	3
	1300	4	227	27.8	1016.3	0
	1900	2	188	26.2	1016.3	0
15	100	3	244	24.4	1017.5	0
	700	12	17	23.6	1020.3	0
	1300	11	31	23.7	1022.7	0
	1900	12	40	22.8	1022.7	0
16	100	11	65	23.0	1022.8	0
	700	11	73	22.9	1021.8	0
	1300	10	67	24.6	1019.6	0
	1900	7	94	22.8	1017.1	0
17	100	7	164	22.2	1012.8	0
	700	6	215	23.3	1010.3	17
	1300	7	214	24.0	1007.8	0
	1900	8	329	20.5	1008.8	0
18	100	9	1	21.7	1010.0	0
	700	7	15	22.3	1011.8	19
	1300	9	21	23.5	1014.1	0
	1900	11	26	22.0	1016.0	0
19	100	12	37	22.0	1016.3	0
	700	13	27	22.0	1018.1	0
	1300	12	17	22.8	1018.4	0
	1900	11	26	22.2	1017.9	0
20	100	8	38	21.4	1017.9	0
	700	7	38	21.8	1018.6	0
	1300	6	19	23.1	1018.5	0
	1900	4	69	21.2	1018.5	0

Table 3
Meteorological Data (concluded)

Sep 1995						
Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	2	1	20.8	1019.3	0
	700	4	80	22.7	1019.8	0
	1300	4	1	25.6	1019.4	0
	1900	5	120	23.1	1018.4	0
22	100	6	132	23.2	1017.6	0
	700	6	142	25.0	1016.7	0
	1300	8	182	26.3	1015.2	0
	1900	7	177	24.8	1013.9	0
23	100	17	353	18.2	1016.8	0
	700	14	1	17.0	1019.9	0
	1300	16	359	16.7	1021.1	0
	1900	13	19	17.4	1021.4	0
24	100	11	40	18.3	1020.7	0
	700	12	27	18.9	1020.0	5
	1300	9	29	21.4	1018.3	0
	1900	10	30	20.7	1017.8	0
25	100	9	29	20.9	1017.0	0
	700	8	29	21.3	1016.2	0
	1300	6	40	22.9	1015.3	0
	1900	3	36	21.6	1014.1	0
26	100	2	315	19.9	1013.4	0
	700	3	302	18.2	1013.9	0
	1300	4	210	21.9	1013.1	0
	1900	0		19.9	1012.2	0
27	100	5	350	19.6	1013.6	0
	700	8	13	19.7	1015.3	0
	1300	6	21	21.6	1016.6	0
	1900	5	37	20.2	1017.2	0
28	100	4	25	20.6	1018.4	0
	700	8	19	21.5	1019.0	0
	1300	6	30	23.0	1019.9	0
	1900	7	26	20.7	1019.9	0
29	100	10	33	20.7	1020.0	0
	700	12	36	21.6	1020.8	0
	1300	11	24	22.3	1021.1	0
	1900	11	40	20.8	1021.2	0
30	100	10	24	20.6	1021.0	0
	700	12	28	20.7	1021.4	3
	1300	10	20	21.6	1021.5	0
	1900	10	30	19.8	1020.7	0
		Resultant	Mean	Mean	Total	
		5	32	22.4	1017.4	92

3 Wave Data

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using an iterative maximum likelihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

**Table 4
Wave Data**

Sep 1995										
Day	Hour	641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
		Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.52	11.7	0.73	11.7	0.78	12.0	102	0.89	11.7
	0700	0.44	10.7	0.73	11.2	0.73	10.8	74	0.82	10.7
	1300	0.57	11.7	0.74	10.3	0.78	10.8	96	0.80	10.7
2	1900	0.41	11.7	0.66	11.7	0.70	10.8	76	0.83	11.2
	0100	0.68	11.7	0.84	11.2	0.87	10.8	100	1.09	10.7
	0700	0.66	5.3	1.25	5.4	1.33	12.0	74	1.47	12.2
3	1300	0.65	12.2	0.84	11.2	0.92	12.0	96	1.06	11.2
	1900	0.55	4.1	0.92	11.2	0.94	12.0	96	1.03	11.7
	0100	0.55	9.9	0.89	10.7	1.01	12.0	86	1.11	10.3
4	0700	0.56	12.9	1.00	11.7	1.18	12.0	90	1.33	12.2
	1300	0.78	12.2	1.17	12.2	1.23	12.0	74	1.42	12.2
	1900	0.63	12.2	1.12	11.2	1.22	12.0	96	1.30	11.2
5	0100	0.82	12.2	1.20	11.2	1.38	10.8	68	1.51	11.2
	0700	0.65	12.9	1.06	12.2	1.21	12.0	94	1.16	11.7
	1300	0.65	11.7	1.03	11.2	1.19	12.0	94	1.21	11.2
6	1900	0.57	15.1	1.00	10.3	1.14	10.8	60	1.15	9.9
	0100	0.63	13.5	0.97	10.3	1.08	10.8	82	1.20	11.2
	0700	0.58	16.0	0.98	15.1	1.10	13.6	96	1.13	12.9
7	1300	0.68	14.3	1.11	14.3	1.13	13.6	90	1.28	13.5
	1900	0.71	14.3	1.10	13.5	1.09	13.6	88	1.15	14.3
	0100	0.69	12.9	1.07	12.9	1.14	13.6	96	1.16	16.0
8	0700	0.72	15.1	1.04	12.9	1.14	15.7	106	1.28	15.1
	1300	0.70	13.5	1.15	13.5	1.27	13.6	102	1.33	14.3
	1900	0.90	15.1	1.13	14.3	1.21	12.0	104	1.43	14.3
9	0100	0.65	15.1	1.09	15.1	1.18	13.6	102	1.31	14.3
	0700	0.85	13.5	1.02	14.3	1.08	13.6	100	1.16	13.5
	1300	0.65	12.9	1.01	12.9	1.15	13.6	102	1.26	13.5
10	1900	1.07	14.3	1.18	12.2	1.28	13.6	102	1.42	13.5
	0100	0.67	15.1	1.09	14.3	1.21	13.6	102	1.38	14.3
	0700	0.92	15.1	0.96	14.3	1.12	15.7	106	1.28	15.1
11	1300	0.65	15.1	0.98	13.5	1.09	13.6	100	1.13	14.3
	1900	1.03	14.3	1.07	14.3	1.20	15.7	104	1.27	14.3
	0100	0.77	16.0	1.14	16.0	1.20	15.7	104	1.38	15.1
12	0700	1.31	14.3	1.32	14.3	1.43	15.7	106	1.80	15.1
	1300	0.80	17.1	1.26	17.1	1.50	15.7	106	1.53	15.1
	1900	1.49	17.1	1.77	16.0	1.91	18.5	92	2.44	17.1
13	0100	0.85	21.4	1.50	16.0	1.71	15.7	90	1.93	16.0
	0700	1.00	14.3	1.14	14.3	1.19	15.7	94	1.38	13.5
	1300	0.79	14.3	1.39	12.2	1.55	12.0	76	1.44	11.7
14	1900	0.92	11.7	1.34	10.7	1.42	12.0	72	1.58	11.7

Table 4
Wave Data (continued)

Sep 1995											
Day	Hour	641		625		3111			630		
		Pressure Hmo,m	Gauge Tp,sec	Baylor Hmo,m	Gauge Tp,sec	8 Meter Hmo,m	Array Tp,sec	Dir, TN	Waverider Hmo,m	Tp,sec	
11	0100	0.72	11.2	1.29	11.2	1.51	10.8	72	1.53	11.2	
	0700	0.86	9.5	1.31	9.5	1.35	9.8	66	1.43	9.5	
	1300	0.65	8.9	1.26	8.9	1.28	8.9	78	1.36	8.9	
12	1900	0.71	8.1	1.24	10.7	1.34	5.6	52	1.48	4.9	
	0100	0.57	11.2	1.13	11.2	1.16	10.8	66	1.23	11.2	
	0700	0.63	10.3	1.03	10.7	1.05	9.8	64	1.12	9.9	
13	1300	0.45	7.2	0.87	7.8	0.98	8.9	70	1.08	9.5	
	1900	0.64	8.1	1.08	7.8	1.10	8.2	78	1.15	7.8	
	0100	0.58	7.8	0.89	7.8	0.94	7.6	72	1.05	7.4	
14	0700	0.56	7.4	0.83	6.8	0.89	7.1	80	0.94	6.1	
	1300	0.42	6.3	0.72	7.2	0.72	6.6	84	0.78	7.0	
	1900	0.41	5.9	0.64	10.3	0.66	10.8	76	0.76	11.2	
15	0100	0.36	13.5	0.58	9.9	0.62	9.8	80	0.70	9.5	
	0700	0.46	11.7	0.62	11.7	0.70	12.0	98	0.71	12.2	
	1300	0.45	11.2	0.57	11.2	0.61	10.8	98	0.63	11.2	
16	1900	0.34	11.2	0.56	10.7	0.56	10.8	78	0.60	10.7	
	0100	0.36	11.2	0.54	11.2	0.60	10.8	86	0.64	10.7	
	0700	0.69	4.4	1.13	10.7	1.37	4.6	40	1.28	4.5	
17	1300	0.85	6.6	1.60	6.5	1.72	6.2	50	1.79	6.3	
	1900	0.63	5.3	1.43	6.5	1.62	6.6	52	1.75	6.5	
	0100	0.93	6.1	1.59	6.5	1.63	6.6	54	1.80	6.0	
18	0700	0.70	6.8	1.59	5.9	1.71	6.2	50	1.72	6.7	
	1300	0.86	8.3	1.38	6.5	1.57	5.6	78			
	1900	0.65	8.9	1.36	6.6	1.49	7.6	64			
19	0100	0.76	8.3	1.25	8.3	1.28	8.2	82			
	0700	0.62	7.2	1.11	7.4	1.21	8.2	64			
	1300	0.68	7.0	0.89	7.8	1.03	8.2	80			
20	1900	0.56	8.6	0.90	8.6	0.99	8.2	80			
	0100	0.66	4.5	1.03	8.3	1.06	7.6	84			
	0700	0.49	4.7	0.93	8.6	0.96	4.8	32			
19	1300	0.64	14.3	1.02	4.9	1.12	4.8	34			
	1900	0.74	5.4	1.40	5.7	1.62	5.6	50			
	0100	1.03	14.3	1.72	6.0	1.81	6.2	68	inoperative		
20	0700	0.97	13.5	1.86	6.1	2.15	6.6	62			
	1300	1.17	12.9	1.93	6.3	2.15	13.6	106			
	1900	1.05	14.3	1.86	6.3	2.06	6.6	56			
20	0100	0.94	12.9	1.84	8.1	1.98	8.2	62			
	0700	0.83	10.7	1.47	9.2	1.66	8.9	68			
	1300	0.85	9.9	1.40	8.9	1.53	9.8	66			
20	1900	0.67	9.9	1.17	10.3	1.35	10.8	88			

Table 4
Wave Data (concluded)

Sep 1995										
Day	Hour	641		625		3111			630	
		Pressure Hmo,m	Gauge Tp,sec	Baylor Hmo,m	Gauge Tp,sec	8 Meter Array			Waverider	
						Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.69	10.3	1.07	10.7	1.26	9.8	68		
	0700	0.67	8.9	1.16	11.2	1.36	12.0	66		
	1300	0.66	11.7	1.16	11.7	1.34	12.0	64		inoperative
	1900	0.61	7.8	1.00	9.5	1.12	12.0	56		
22	0100	0.52	10.7	0.99	10.7	1.12	10.8	64		
	0700	0.45	11.7	0.85	11.7	0.97	12.0	84		
	1300	0.43	10.7	0.84	10.7	0.90	10.8	60		
	1900	0.40	10.3	0.73	10.7	0.73	10.8	64		
23	0100	0.69	6.1	1.74	6.5	2.08	6.2	26		
	0700	1.08	6.8	1.86	6.8	2.16	7.1	54		
	1300	0.72	7.6	1.98	7.4	2.22	7.1	50		
	1900	1.03	7.6	1.75	7.2	1.96	6.2	50		
24	0100	0.65	7.0	1.58	6.3	1.75	6.6	54		
	0700	0.97	5.4	1.56	5.9	1.69	5.9	56		inoperative
	1300	0.65	5.9	1.48	6.0	1.52	6.2	54		
	1900	0.96	5.3	1.45	6.0	1.58	5.9	70		
25	0100	0.66	5.7	1.37	7.6	1.48	7.1	58		
	0700	0.92	4.6	1.35	6.8	1.45	7.6	58		
	1300	0.64	5.1	1.21	7.8	1.24	7.1	70		
	1900	0.73	9.2	1.11	9.2	1.15	8.2	60		
26	0100	0.58	9.9	1.00	8.6	1.04	8.9	64		
	0700	0.57	9.2	0.94	9.5	0.98	8.9	62		
	1300	0.47	10.3	0.82	9.9	0.89	9.8	68		
	1900	0.55	9.5	0.90	9.2	0.95	9.8	72		
27	0100	0.42	10.7	0.75	8.9	0.77	8.9	68		
	0700	0.57	10.3	0.82	8.9	0.94	9.8	66		inoperative
	1300	0.49	4.4	0.74	9.9	0.78	8.9	72		
	1900	0.47	7.8	0.72	8.3	0.74	8.9	70		
28	0100	0.33	9.5	0.61	9.9	0.67	9.8	58		
	0700	0.40	9.5	0.67	8.9	0.69	8.9	60		
	1300	0.47	4.2	0.75	9.9	0.71	9.8	82		
	1900	0.36	9.9	0.62	7.8	0.67	8.9	64		
29	0100	0.69	4.9	1.06	4.8	1.19	5.0	54		
	0700	0.84	6.1	1.51	5.9	1.67	5.9	46		
	1300	0.93	5.6	1.45	6.3	1.67	5.9	54		
	1900	0.75	7.4	1.80	6.6	2.14	8.2	80		
30	0100	1.04	9.5	1.92	9.5	2.03	9.8	72		
	0700	0.91	9.5	2.12	9.2	2.17	9.8	84		
	1300	1.17	9.2	1.75	9.9	1.89	9.8	68		
	1900	0.77	11.2	1.73	9.5	1.88	10.8	70		
Mean		0.70	10.2	1.16	9.9	1.26	10.0	74	1.25	11.4
Std dev		0.21	3.5	0.36	2.8	0.41	3.0	18	0.34	2.9

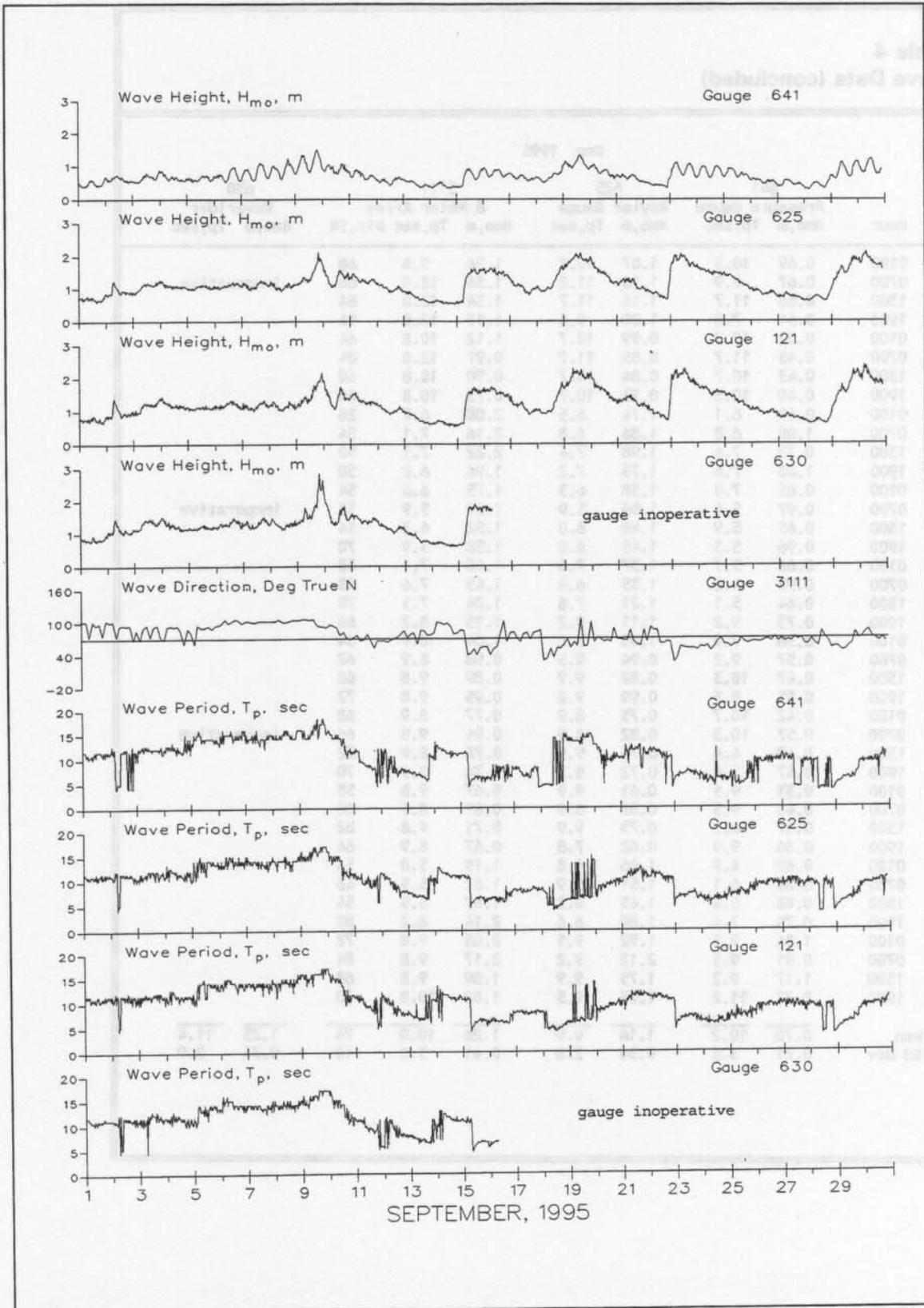


Figure 5. Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 3539

SEPTEMBER 1995																	
Cross Long					Cross Long					Cross Long							
Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir	Day	Time	Shore	Shore	Speed	Dir
1	100	5	-11	13	318	11	100					21	100				
	700	5	-13	14	320		700						700				
	1300	4	-13	15	323		1300						1300				
	1900	6	-9	12	307		1900						1900				
2	100	2	1	2	226	12	100			inoperative		22	100				inoperative
	700	1	11	11	163		700						700				
	1300	-1	3	3	125		1300						1300				
	1900	2	10	10	174		1900						1900				
3	100	6	13	15	185	13	100					23	100				
	700	3	9	10	180		700						700				
	1300	1	-1	3	312		1300						1300				
	1900	4	4	5	201		1900						1900				
4	100	0	-2	3	354	14	100					24	100				
	700	4	8	9	188		700						700				
	1300	2	-4	5	319		1300						1300				
	1900	-1	0	2	40		1900						1900				
5	100	4	-5	7	306	15	100			inoperative		25	100				inoperative
	700	1	0	2	238		700						700				
	1300	0	-7	8	348		1300						1300				
	1900	5	0	5	253		1900						1900				
6	100	3	-5	7	310	16	100					26	100				
	700	2	0	2	279		700						700				
	1300	0	-11	12	347		1300						1300				
	1900	3	-5	7	314		1900						1900				
7	100	3	-6	7	317	17	100					27	100				
	700	2	1	3	226		700						700				
	1300	3	-8	10	324		1300						1300				
	1900	5	-4	7	296		1900						1900				
8	100	4	-6	8	309	18	100					28	100				
	700	0	-3	4	351		700						700				
	1300	3	0	3	249		1300						1300				
	1900	5	-3	6	287		1900						1900				
9	100					19	100					29	100				
	700						700						700				
	1300				inoperative		1300			inoperative			1300				inoperative
	1900						1900						1900				
10	100					20	100					30	100				
	700						700						700				
	1300						1300						1300				
	1900						1900						1900				

KEY:
 +cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Sep 1995											
Pier End				Mid-Surf Zone				Beach			
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	-11	-36	37	323	21	-47	51	4	South	44	N
2	5	30	31	151	-9	61	62	169	North	24	S
3	-14	47	49	177	-7	12	14	250	North	26	S
4	2	23	24	154	-2	5	5	250	North	38	S
5	-4	28	28	169	0	0	0		North	20	S
6	0	0	0		0	-61	61	340	South	14	N
7	-10	-34	35	323	-30	-29	42	294	South	57	N
8	10	5	11	70	-13	-32	35	318	South	58	N
9	0	0	0		-4	-87	87	337	South	112	N
10	8	55	56	151	0	-24	24	340	South	36	N
11	-19	12	22	216	0	0	0		North	30	S
12	15	10	18	104	6	28	28	149	North	11	S
13	1	-4	4	349	0	-15	15	340	South	26	N
14	11	-32	34	359	11	-36	37	357	South	30	N
15	-7	27	27	174	3	55	55	157	North	85	S
16	27	10	29	70	-10	51	52	171	North	17	N
17	6	-25	26	354	14	-34	36	2	South	31	N
18	-4	38	38	166	3	30	31	154	South	47	S
19	-23	22	32	206	-18	61	64	177	North	11	S
20	2	36	36	157	22	20	30	112	North	10	N
21	0	0	0		20	68	71	143	North	16	S
22	0	-44	44	340	0	0	0		South	39	N
23	-13	51	52	174	-5	102	102	163		no observation	
24	-1	23	23	163	-2	47	47	163		no observation	
25	-2	36	36	163	-5	34	34	169		no observation	
26	1	14	14	157	8	14	16	131	North	34	S
27	-14	34	36	182	0	41	41	160	North	57	S
28	-5	25	26	171	0	25	25	160	North	25	S
29	-16	36	39	184	-7	68	68	166	North	43	S
30	-10	28	29	179	-9	61	62	169	North	21	S

KEY:
 +cross-shore = offshore, cm/sec
 -cross-shore = onshore, cm/sec
 +longshore = south, cm/sec
 -longshore = north, cm/sec
 Speed = Resultant speed, cm/sec
 Dir = Resultant direction, degrees true north

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and depth of visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Sep 1995								
Day	Time	Wave Approach		Radar Wave Angle deg from True N	Width of Surf Zone, m	Water Characteristics at Pier End		
		Angle at Pier End deg from True N	Primary Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	0732	95			132	25.0	1.0225	0.3
2	0841	30			147	24.4	1.0231	0.3
3	0833	40			178	24.7	1.0204	1.5
4	0616	80			166	24.7	1.0201	0.9
5	0653	80	40		157	24.4	1.0199	2.7
6	0708	85			143	24.7	1.0201	1.5
7	0648	100			172	24.7	1.0205	1.5
8	0753	90			123	24.4	1.0226	0.9
9	0830	100			141	24.7	1.0230	0.3
10	0837	85			136	25.3	1.0201	1.8
11	0738	50			155	24.7	1.0204	1.5
12	0723	50			144	24.2	1.0204	0.9
13	0726	80			105	25.0	1.0202	2.4
14	0715	90			118	24.7	1.0220	0.6
15	0653	30			153	24.7	1.0228	0.3
16	0840	75	60		195	24.2	1.0226	0.9
17	0850	100	75		153	24.7	1.0225	0.6
18	0709	35	65		118	24.2	1.0225	0.6
19	0746	45			303	23.9	1.0223	0.3
20	0731	60	80		187	23.6	1.0217	1.5
21	0720	70			153	23.9	1.0209	0.9
22	0717	70	115		106	24.3	1.0212	0.6
23	0630	40			152	23.3	1.0230	1.2
24	0630	30			154	21.9	1.0226	1.2
25	1050	60			134	22.2	1.0218	1.2
26	0724	50			110	22.2	1.0203	1.2
27	0647	60	20		117	22.8	1.0201	0.9
28	0659	65	30		31	23.0	1.0204	1.8
29	0719	40	65		193	22.5	1.0204	1.2
30	0736	70	50		305	22.2	1.0211	0.6

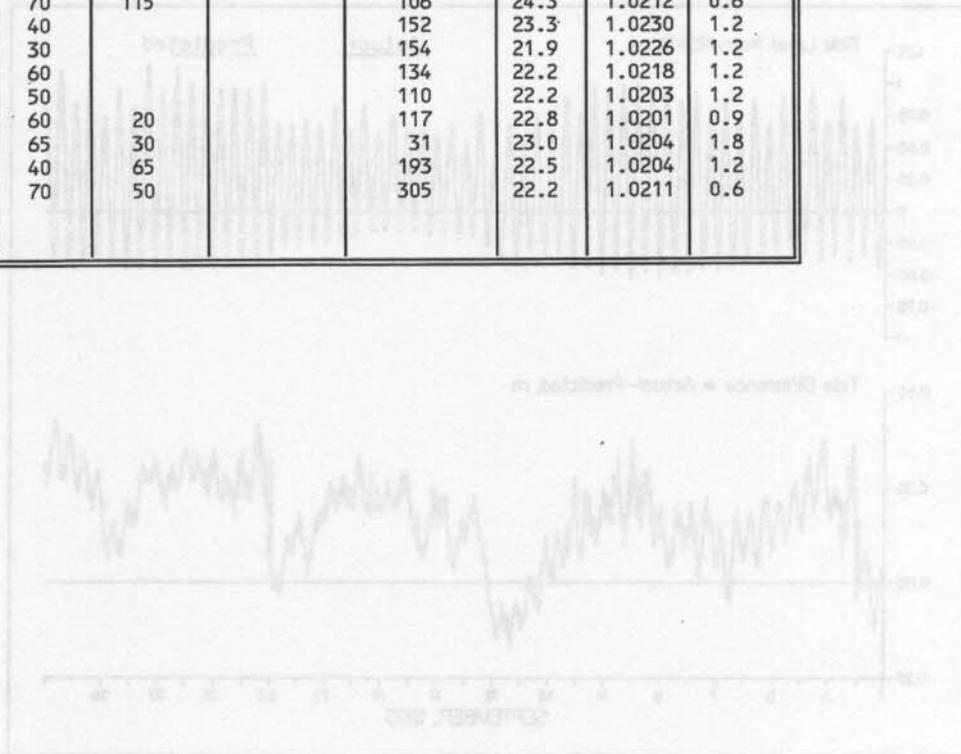


Figure 8. Water Level Variation

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

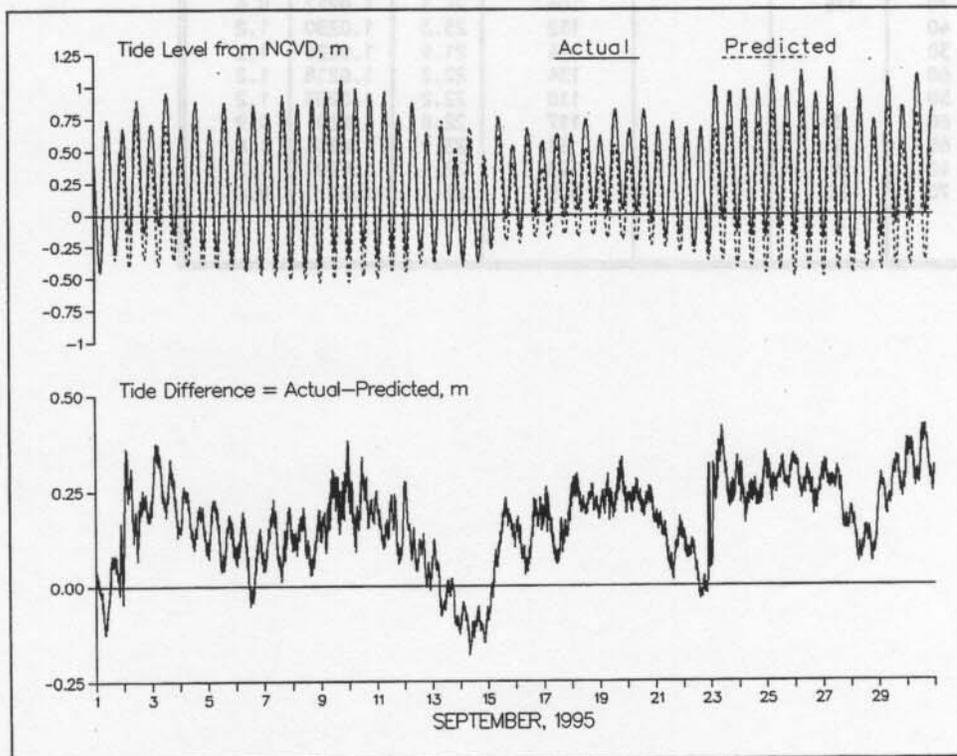


Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

SEP 1995 Tide Levels															
High		Low		Mean		Range		High		Low		Mean		Range	
Day	Time	m	Day	Time	m	m	m	Day	Time	m	Day	Time	m	m	m
1	1154	0.72	1	0548	-0.45	0.13	1.17	16	1200	0.67	16	0530	-0.15	0.28	0.82
2	0100	0.68	1	1806	-0.31	0.19	0.99	17	0124	0.57	16	1906	-0.02	0.29	0.59
2	1306	0.89	2	0600	-0.14	0.35	1.03	17	1412	0.63	17	0724	-0.06	0.29	0.69
3	0142	0.71	2	1854	-0.14	0.30	0.85	18	0124	0.63	17	1936	-0.03	0.31	0.66
3	1342	0.95	3	0736	-0.08	0.43	1.03	18	1424	0.75	18	0718	0.03	0.40	0.71
4	0230	0.67	3	2012	-0.16	0.26	0.83	19	0300	0.62	18	2030	-0.04	0.32	0.58
4	1530	0.89	4	0842	-0.24	0.33	1.13	19	1536	0.82	19	0824	-0.02	0.42	0.84
5	0324	0.67	4	2106	-0.26	0.21	0.93	20	0354	0.67	19	2206	0.03	0.35	0.63
5	1612	0.88	5	1000	-0.28	0.28	1.16	20	1548	0.82	20	0954	0.02	0.41	0.80
6	0442	0.69	5	2200	-0.34	0.19	1.03	21	0418	0.69	20	2236	-0.07	0.30	0.76
6	1654	0.85	6	1054	-0.43	0.20	1.28	21	1718	0.72	21	1018	-0.19	0.27	0.91
7	0542	0.79	6	2312	-0.43	0.20	1.23	22	0506	0.68	21	2230	-0.16	0.25	0.84
7	1724	0.94	7	1130	-0.41	0.26	1.34	22	1748	0.68	22	1100	-0.27	0.19	0.95
8	0630	0.86	8	0018	-0.42	0.24	1.28	23	0530	1.00	22	2336	-0.32	0.40	1.32
8	1900	0.89	8	1206	-0.42	0.24	1.31	23	1842	0.96	23	1230	-0.05	0.45	1.01
9	0636	0.96	9	0048	-0.42	0.29	1.38	24	0706	0.97	24	0012	-0.15	0.41	1.12
9	1906	1.05	9	1248	-0.29	0.38	1.34	24	1836	0.97	24	1224	-0.17	0.41	1.15
10	0742	0.99	10	0124	-0.33	0.35	1.32	25	0724	1.08	25	0048	-0.19	0.46	1.27
10	1930	0.94	10	1400	-0.25	0.35	1.19	25	1948	0.99	25	1306	-0.12	0.44	1.11
11	0842	0.96	11	0206	-0.34	0.31	1.30	26	0812	1.12	26	0148	-0.17	0.46	1.29
11	2054	0.77	11	1436	-0.29	0.27	1.06	26	2024	0.95	26	1424	-0.22	0.37	1.16
12	0836	0.87	12	0254	-0.29	0.29	1.16	27	0818	1.14	27	0218	-0.20	0.47	1.34
12	2112	0.64	12	1512	-0.28	0.17	0.92	27	2042	0.82	27	1506	-0.19	0.31	1.00
13	1012	0.69	13	0330	-0.34	0.17	1.03	28	0948	0.96	28	0324	-0.32	0.31	1.28
13	2224	0.44	13	1606	-0.32	0.04	0.76	28	2154	0.74	28	1548	-0.29	0.23	1.03
14	1042	0.58	14	0430	-0.41	0.07	0.99	29	1006	1.07	29	0412	-0.18	0.44	1.25
14	2312	0.40	14	1712	-0.38	0.00	0.78	29	2230	0.84	29	1700	-0.08	0.38	0.92
15	1106	0.76	15	0418	-0.27	0.27	1.03	30	1142	1.09	30	0454	-0.07	0.52	1.16
15	2342	0.54	15	1818	-0.04	0.25	0.57								

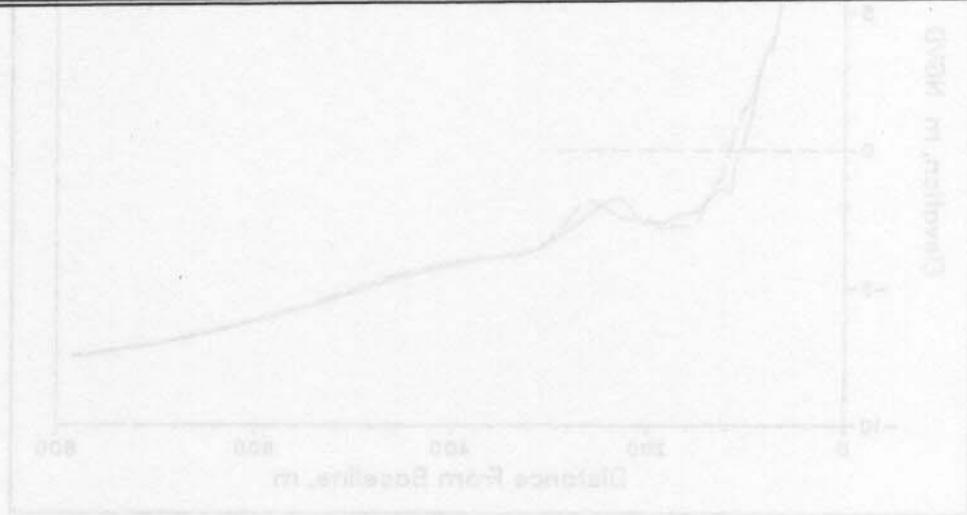


Figure 7. Monthly CRAB Profiles on Profile Line 188.

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in August 1995 and the survey(s) in September 1995 on profile line 188, located 517 m south of the pier.

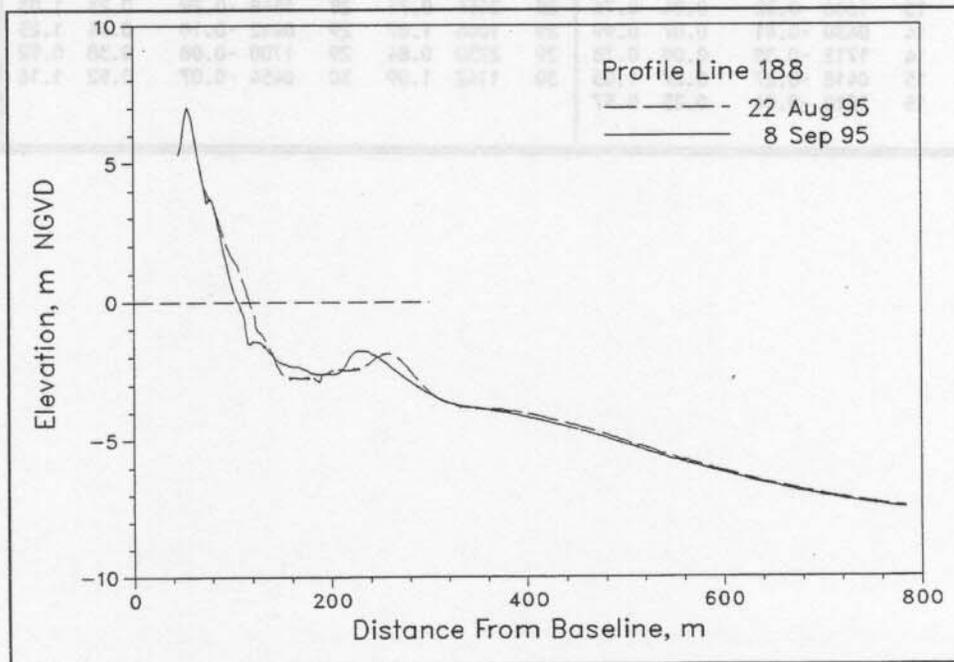


Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1995. Cross-hatched areas indicate changes to the annual envelope which occurred in September.

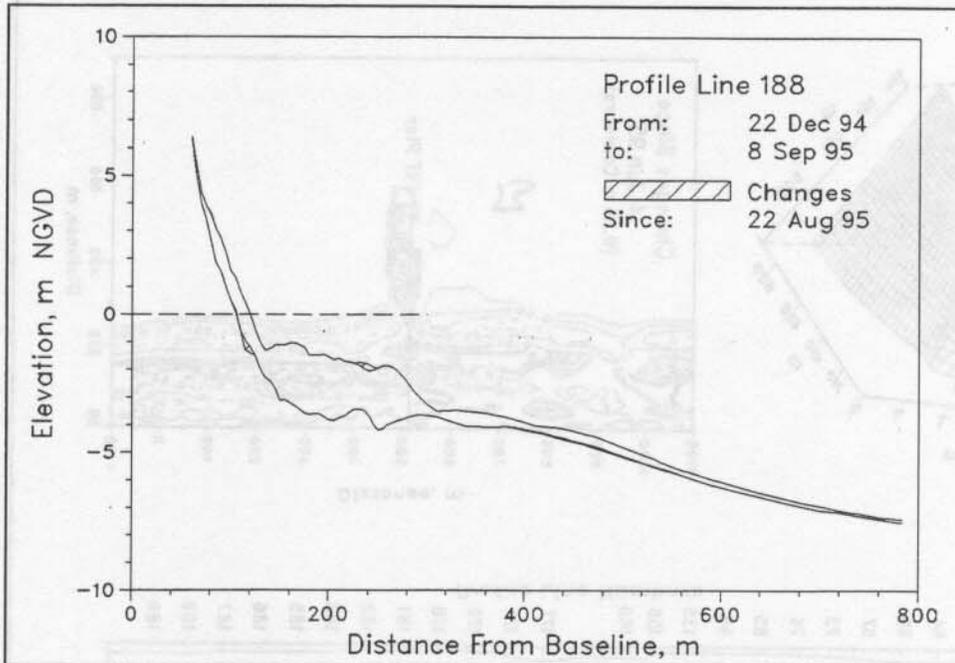


Figure 8. Profile Envelope - Profile Line 188.

B. **Bathymetry.** Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 22 August. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

There was no bathymetric survey in September. Figure 9 is included for reference only.

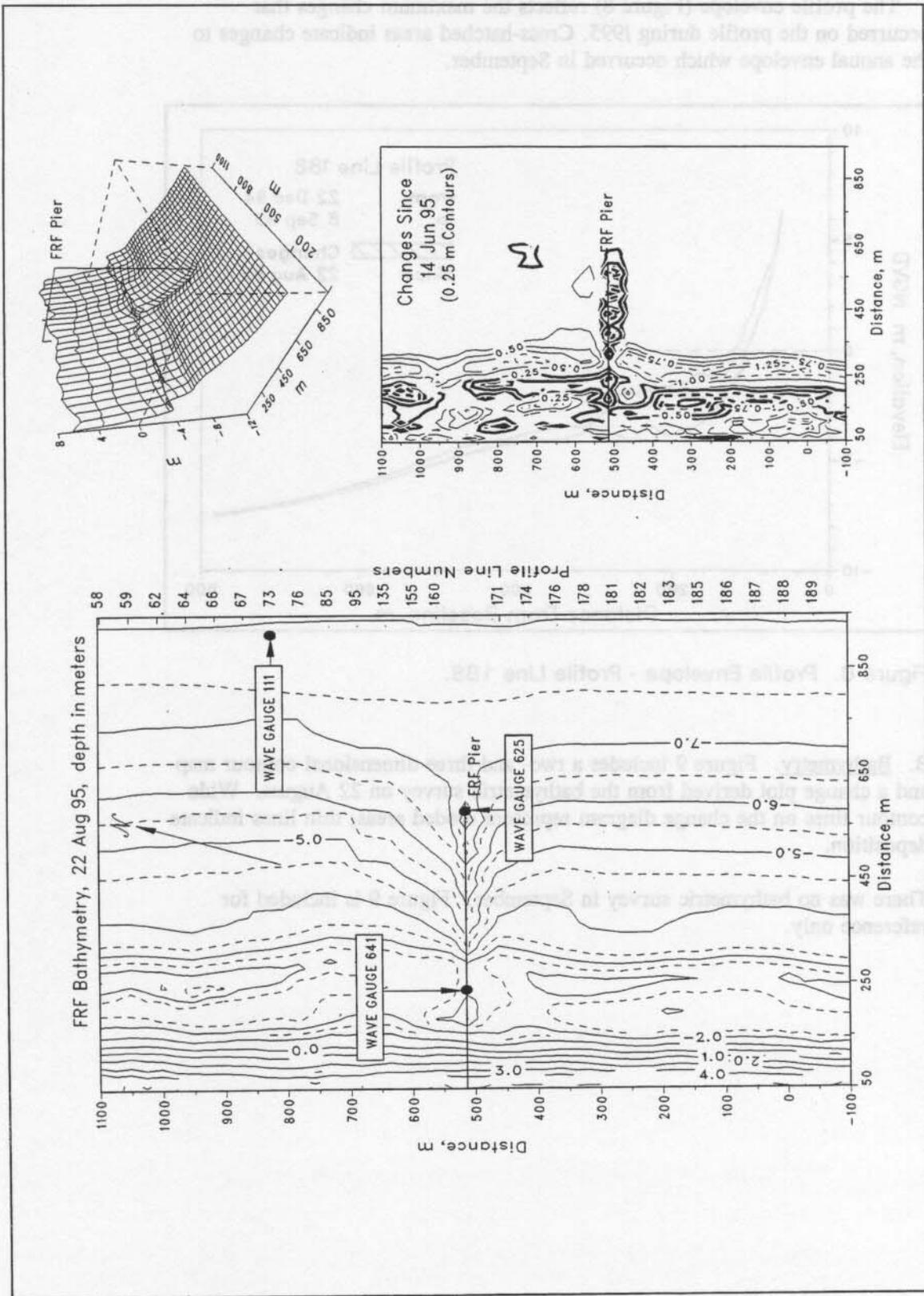


Figure 9. FRF Bathymetry, Depths Relative to NGVD

8 Special Events

A. Storm Data Collection. The following list identifies times when the wave height H_{mo} at the seaward end of the pier exceeded 2 m.

<u>Start</u>	<u>End</u>
19 Sep (1000)	19 Sep (2342)
23 Sep (0434)	23 Sep (1334)
29 Sep (2008)	30 Sep (0734)

B. Storm Synopsis.

19 Sep Northeasterly winds associated with a Canadian high pressure system reached 13 m/s at 1034 EST. The maximum H_{mo} , at gauge 625, reached 2.1 m ($T_p=6.9$ s) at 1108 EST. There was no precipitation.

23 Sep Northeasterly winds associated with a warm front, reached 15 m/s at 0916 EST. The maximum H_{mo} , at gauge 625, reached 2.1 m ($T_p=6.9$ s) at 1000 EST. There was no precipitation.

29-30 Sep Northeasterly winds associated with a Canadian high pressure system reached 13 m/s at 0434 EST on 30 September. The maximum H_{mo} , at gauge 625, reached 2.1 m ($T_p=9.5$ s) at 0542 EST on 30 September. There was 3 mm of precipitation.

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge	U.S. Geological Survey
USACE-OCE	U.S. Library of Congress
USACE-SAD	U.S. National Park Service
USACE-NAP	U.S. National Weather Service
USACE-SAW	U.S. Naval Academy
USACE-WES	U.S. Naval Civil Eng. Lab
NAVSAC	U.S. Naval Oceanographic Off.
NOAA/NOS/OMS	U.S. Naval Research Lab
National Marine Fisheries	

Colleges/Universities:

Bucknell University	Scripps Institution of Oceanography
California Inst. of Tech.	Stockton State College
Duke Marine Lab	University Calif-Berkeley
East Carolina University	University of Florida
Florida Inst. of Tech.	University of Maryland-College Park
M.I.T.	University of Maryland-Baltimore
Naval Post Graduate School	University of North Carolina
NC State University	University of N C-Seagrant Program
Old Dominion University	University of Virginia
Oregon State University	Va. Inst. of Marine Science
Prince George's College	Rutgers University

Others:

Allied Signal Aerospace Co.	WCTI-TV
Applied Physics Lab	MEC Systems Corporation
Cape Hatteras Nat. Seashore	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	N.C. Div. Coastal Management
Coastal Science & Eng., Inc.	Oregon Inlet & Waterways Commis.
Dr. Cy Galvin	Raleigh-Durham Airport
GEOMET Tech., Inc.	Mr. Rowland
Mr. Hodges	Mr. Savage
Dr. Hylton	Science Application Int'l. Corp
Mr. Mason	Sherwood Industries
Mr. Rodgers	SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)